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ABSTRACT

A project was designed to develop a curriculum model based on salient, sequenced occupational tasks. After an extensive literature review and staff discussions, a modified Q-Sort procedure was formulated to select and sequence tasks. The procedure made it possible to readily utilize a catalogue of tasks compiled by the Vocational-Technical Consortium of States (V-TECS). The tasks were used to develop a competency based modular vocational and technical model. Two general automotive task outlines were prepared as examples of the application of the sorting procedure. The outlines are intended to serve as models for subsequent instructional program designs which employ V-TECS catalogues. Also, a procedure handbook for local educators (included as Appendix A) was written to detail procedures for using V-TECS occupational catalogues to develop competency based modular instructional programs. (CSS)

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Final Report

The Development of a Procedure for the Design of Competency Based Modular Instructional Programs

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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1978

Abstract

Project: The Development of a Procedure for the Design of Competency Based Modular Instructional Programs

Funding Agency: Maryland State Department of Education

Project Director: Dennis R. Herschbach, University of Maryland

Project Description: The State of Maryland is a member of the Vocational-Technical Consortium of States, Southern Association of Colleges and Schools Commission on Occupational Education Institutions. This is known as V-TECS. Accordingly, Maryland vocational educators have available to them V-TECS occupational catalogues in a wide number of fields. Each catalogue is an extensive, unsequenced task listing that can serve as the foundation on which instructional programs can be structured. Each catalogue, however, includes more tasks than are needed for any one instructional program. Moreover, these tasks are not arranged in accordance to their order for learning.

How can the most important tasks in terms of local program needs be selected? Furthermore, how can the selected tasks be sequenced in order to facilitate optimum instructional effectiveness? It is the purpose of this project to address these problems. A selection and sequencing procedure is presented. This includes the application of a modified Q-Sort technique, and includes the use of a local instructional design committee. Examples of the Q-Sort technique applied to task selection are also presented, and a rationale for decision-making is discussed.

Body of Evaluation

Introduction

The State of Maryland is a member of the Southern Association of Colleges and Schools Commission on Occupational Education Institutions, Vocational-Technical Consortium of States. In short, this organization is known as V-TECS. One of the purposes of V-TECS is to develop curriculum materials to be shared by member states. Accordingly, Maryland vocational educators have available to them occupational catalogues in a wide number of fields. Each catalogue contains a comprehensive list of tasks in a specific occupational area, performance objectives, performance guides, and criterion-referenced measures. This is an excellent source of curriculum information. The data included in each catalogue have been validated through rigorous analysis procedures. They are also current and comprehensive.

A V-TECS occupational catalogue, however, does not constitute a ready-made curriculum. Rather it is an extensive, unsequenced task listing that can serve as the foundation on which instructional programs can be structured. From the large number of occupational tasks included in a V-TECS catalogue, it is necessary for the educator to select only the most salient tasks for training. This selection should be carried out in accordance with local program needs. It is also necessary to sequence, in a meaningful way, the tasks which are selected. Each V-TECS catalogue provides a comprehensive list of tasks in an occupational area. However, these tasks are not arranged in accordance to their performance sequence on the job, nor are they sequenced in the best order for learning.

Statement of the Problem

How can the most important tasks in terms of local program needs be selected? Furthermore, how can the selected tasks be sequenced in order to facilitate optimum instructional effectiveness? It is the purpose of this study to address these questions.

Rationale

This project is developmental, and its results will facilitate the use of V-TECS operational catalogues by vocational and technical educators. A selection and sequencing procedure is presented. This involves the application of a modified Q-Sort technique, and includes the use of a local instructional design committee. Examples of the Q-Sort technique applied to task selection are also presented, and a rationale for decision-making is discussed. The purpose is to provide the local vocational educator with the capability of using V-TECS occupational catalogues. However, any procedure

used must be easily understood and applied. It must also only require resources well within the range which normally can be considered as available to the local educator. Such a procedure is presented.

Objectives

The project achieved the following objectives:

1. A modified Q-Sort procedure is developed for task selection and sequencing. This procedure makes it possible to readily utilize V-TECS catalogues for developing competency based modular vocational and technical programs.

2. Two task outlines are presented as examples of the application of the sorting procedure. These outlines serve as models for the subsequent design of instructional programs from a V-TECS catalogue.

3. A procedure handbook is developed (Appendix A) for use by local educators. This handbook details procedures for developing a competency based modular instructional program from V-TECS occupational catalogues.

Methodology

The following methodology was used to conduct the study:

1. Selected V-TECS catalogues and supporting materials were closely studied to develop a thorough understanding of the task selection procedure used and the results produced. This was necessary to clarify the nature of the problem to be addressed. While the V-TECS catalogues provide a thorough analysis of a particular occupational field, they are also characterized by certain problems that must be directly addressed by the local curriculum designer.

2. An extensive review of the literature relating to the Q-Sort technique, instructional design, and competency based instruction was carried out. The source material consulted is listed in Appendix A, page 40.

3. Strategy sessions were held with project staff to explore possible approaches to the development of a task selection and sequencing procedure. A matrix approach was first devised. However, after further development, this approach was discarded because of its complexity. While the results yielded through the use of a decision-making matrix are sound, computer manipulation is involved, a capability felt

to be beyond the reach of most LEA's using the V-TECS catalogues.

4. The current approach included in Appendix A was developed after extensive review and discussion by the project staff. The major advantage of this approach is that it provides a workable means by which the LEA curriculum specialists can deal with a rather complex set of task selection decisons. Moreover, it is felt by the project staff that curriculum decisions can result through the use of this procedure.

5. Two occupational areas were selected by the project director and a representative of the Maryland State Department of Education, Division of Vocational-Technical Education. The task selection procedure developed was used to select tasks in these two areas from a V-TECS catalogue. The task outlines developed serve as examples of the use of this procedure.

6. The procedure handbook included in Appendix A was developed.

Funding

A conceptual framework was developed in which task selection can be carried out. The purpose is to facilitate decision-making at the local level and provide the basis for making task selection judgements. A task selection procedure is also presented. Objectivity in task selection can be fostered through the use of carefully designed procedures. If these procedures are well understood and carefully carried out, greater consistency in decision-making results.

Conclusions and Recommendations

The results of the study should be made available to curriculum specialists in vocational-technical education in the state of Maryland. The procedure handbook included in Appendix A is applicable for use in workshops dealing with the use of V-TECS catalogues or competency based instructional design. It is recommended, however, that a 10 or 12 page booklet be condensed from the main handbook for direct teacher use.

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This research was supported by a grant from the Research Coordinating Unit, Maryland State Department of Education, Division of Vocational-Technical Education. Through the support of the Research Coordinating Unit, it was possible to investigate a number of engaging problems relating to task selection. But this project also had a more practical purpose: to develop a workable approach to the use of a V-TECS catalogue by local instructional designers. As such, we appreciate the opportunity to contribute to the on-going effort in the state of Maryland to address problems of instructional design in vocational and technical education.

A number of individuals assisted us in this project. Kenneth R. Sargent supplied support from the Research Coordinating Unit, and Gerald F. Day, Maryland State Department of Education, helped to coordinate our efforts with those of the Division of Vocational-Technical Education. Ed Roberts helped us field test the sorting procedure and assisted us in layout and graphics. Kathy Sander helped in the preparation of the manuscript and Bonnie Dunn did the final typing. Finally, we would like to thank the vocational teachers who provided a forum for the discussion of many of the ideas developed in the course of this research.

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Introduction

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in the best order for learning.

How can the most important tasks in terms of local program needs be selected? Furthermore, how can the selected tasks be sequenced in order to facilitate optimum instructional effectiveness? It is the purpose of this paper to address these questions. A selection and sequencing procedure is presented. This involves the application of a modified Q-Sort technique, and includes the use of a local instructional design committee. Examples of the Q-Sort technique applied to task selection are also presented, and a rationale for decision-making is discussed. The purpose is to provide the local vocational educator with the capability of using V-TECS occupational catalogues. However, any procedure used must be easily understood and applied. It must also only require resources well within the range which normally can be considered as available to the local educator. Such a procedure is presented.

Appendix

Section A

The Development of a Procedure for the Design of Competency Based Modular Instructional Programs

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This project was supported through a grant from the Research Coordinating Unit, The Maryland State Department of Education, Division of Vocational-Technical Education.

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What is a V-TECS Catalogue?

A V-TECS catalogue is basically a listing of job tasks for a particular occupational area. These tasks are grouped under duty statements. That is, tasks related to a particular job activity, such as "purchasing" or "repairing," are listed together. This not only indicates the relationship of a particular task to the total job, but the grouping of tasks under a duty statement facilitates the organization of instruction. Tasks associated with a particular job function can be easily identified.

A performance objective, a criterion-referenced measure, and performance guides are listed for each task statement (see Figure 1). These instructional components help to teach the task. The performance objective explicitly spells out the student behavior expected at the completion of instruction. The criterion-referenced measure indicates the performance standard that the student must attain in order to demonstrate task mastery, and the performance guides list the steps to be followed in task performance. Once a particular task is selected for instructional purposes, the performance objective, the criterion-referenced measure, and the performance guides associated with that task become instructional components. This is a considerable aid to the instructional designer, since these components have been very carefully developed to reflect actual job activity. By using a V-TECS catalogue as the basis of program design, one is assured that instruction is realistic in

terms of what can be expected on the job.

Duty: Performing Housekeeping Activities

Task: Maintain furnishings, equipment, and supplies

Performance objective:
Given specific equipment and materials used in a day-care center, store all the equipment and/or materials in their assigned places.

Criterion-referenced measure:
Your instructor will assign you specific equipment and/or materials used in a day-care center. Store all items in their assigned places.

Performance guides:
1. Establish criteria for storing a variety of equipment and materials used in a day-care center.
2. Identify assigned storage areas for all of the equipment and materials.
3. Store items in assigned places.

Fig. 1. Example of duty and task statements with performance objective, criterion-referenced measure, and performance guides

The major value of V-TECS material, then, is that it is a fairly accurate portrayal of job activity. Sound methods of data collection and analysis have been used, insuring the content validity of the tasks selected. Subject-matter experts have been relied upon as writing team members, producing consistent and complete descriptive information. Critical review procedures have been carried out, maintaining the validity and clarity reflected in the catalogue. One can be confident that a V-TECS catalogue represents a thorough analysis of a particular occupational field, more so than can be expected if an individual or a Local Educational Agency conducted the analysis.

The Need to Select

A V-TECS catalogue, however, probably includes more tasks than are needed for any one instructional program. This is because the analysis is of a complete occupational field. Most instructional programs only focus on subgroups within a field or selected tasks within a total field. For one thing, time and available resources do not permit otherwise.

All programs have constraints in terms of the instructional resources that can be used. These resources may include facilities, equipment and supplies, staff and support personnel, or instructional time. The instructional designer must work within the boundaries of the available resources. Some job tasks simply cannot be taught because adequate resources are not available. Perhaps an expensive piece of equipment cannot be purchased, or the task is beyond the scope of the instructional staff to handle adequately. Or, perhaps, only a limited number of tasks can be taught because of a limited instructional schedule. Deciding on which tasks to teach involves a realistic assessment of the resources that are available.

It is also important to select only those tasks which are most appropriate for the student population being served. A diversity of students, ranging in background, abilities, interests, behavioral patterns, and aspirations, are served by vocational education. The tasks selected for instructional purposes should have a direct relationship to the specific student group being served. In the case of working with low achieving students, for example, the particular tasks selected for the

instructional program should not be beyond the ability of the students to master. Otherwise, the program is dysfunctional. In such a case, either the instructional content must be altered, or a more remedial level of training must be provided prior to instruction in the higher level tasks.

The occupational goals of students must also be considered. In some cases, these goals are crystalized, and specific training for direct job placement can be given. In other cases, these goals are not yet clearly defined, so the instructional program should not be so restrictive as to prevent objective choices from being made or to limit the exploratory experiences necessary for pursuing various careers.

These and other factors relating to the student population being served should be taken into consideration when selecting which tasks to include in the local instructional program.

Local program aims also have a direct bearing on task selection. Most vocational and technical educators would agree that the major aim of instruction is to prepare students for employment. While this is a generally accepted instructional aim, great variation can exist among programs in terms of the specificity of instruction as well as the breadth of coverage. Some programs, for example, may be designed to provide in-depth skill training in a single job category, while other programs may be designed to provide greater coverage in more content areas, but less depth of coverage. Or, the decision may be made to provide training in certain job tasks through on-the-job training. Again, the purpose of training may be to provide a general overview of a

field, leading to future specialization or, perhaps the purpose may be to provide retraining or upgrading. In each of these cases, the type and number of job tasks selected is a function of the specific program aim. Within the general framework of providing preparation for employment, then, there is variation concerning the specific aim of instruction. Similarly, variation also exists in regard to task selection.

Thus, while a V-TECS catalogue represents a sound analysis of an occupational field, there are other factors, however, that need to be considered when selecting the tasks to include in an instructional program. To be sure, actual job activity is the source of instructional content for vocational and technical programs. A V-TECS catalogue provides a comprehensive and representative identification of job activity. But, in order to use a V-TECS catalogue, it is necessary to take into account local considerations. These include instructional resources and constraints, the student population being served, and specific local program aims. Based upon these considerations, certain job tasks can be selected for inclusion in the instructional program. Other job tasks can be excluded.

The Nature of the Instructional Design Process

How can local considerations be taken into account when selecting tasks from a V-TECS catalogue? What are the procedures to follow? The major purpose of this paper is to address these questions. First, however, let us briefly examine the nature of the instructional design process.

As previously suggested, rigorous data collection and analysis methods are used to develop a V-TECS catalogue. The intent is to produce a catalogue that is objective and comprehensive, and one that reflects realistic job activity. But the process of developing a V-TECS catalogue also involves a considerable amount of judgement on the part of the investigators. The same can be said of using a V-TECS catalogue, especially when selecting tasks consonant with local considerations. The instructional design process, in other words, is one in which judgement is fundamental to decision-making.

To say that instructional design involves considerable judgement does not mean that this process is less rigorous or involves less conceptual accuracy than other educational activities. Many activities involve judgement; important decisions are made every day based mainly on judgement: buying and selling stock, budgeting, planning new housing developments, making judicial decisions, as well as scheduling bus routes, determining the school cafeteria menu, and assigning student grades. Judgement is fundamental to human activity.

It is important, however, to make sound judgements based on objective decision-making. Chance, bias, inconsistency, and personal preference should be reduced to the minimum. One way to do this is to develop a conceptual framework in which to view decision-making. Clarity of thought, consistency, and continuity of ideas result. It is necessary to first adequately conceptualize the decisions that need to be made before actually making them.

Since in the case of instructional design, local judgements must come into full play, the use of the V-TECS materials can be best facilitated by providing a larger conceptual framework in which decisions can be directly addressed. The local specialist needs to have the capability to select instructional tasks according to local requirements, while at the same time the basis of this selection must be explicit and educationally defensible.

The following section discusses task selection and develops a conceptual framework in which this can be carried out. Its purpose is to facilitate decision-making at the local level and provide the basis for making task selection judgements.

Objectivity in instructional design can also be fostered through the use of carefully designed procedures. If these procedures are well understood and carefully carried out, greater consistency in decision-making results. A task selection procedure is also presented in a following section.

Fundamental to the procedure presented is the use of an instructional design committee. A committee can facilitate the instructional design process: the opportunity is available to interact with one another, achieving greater understanding; different views are presented, so decisions are not one-sided; there is a greater variety of expertise represented; and work is shared. In short, the use of a committee helps produce sound instructional design decisions.

While the instructional design process requires decision-making, these decisions are not a one-time event. One must work

back and forth between tentative decisions, new information or judgements, and new decisions. The decision-making process is transactional; in other words, tentative decisions are reached and additional informational input in turn alters these decisions. This is especially true when considering the interrelationship between instructional resources, the student population served, and specific program aims. One must make initial decisions, and expect these decisions to be altered as other input is considered.

Task Selection Decisions

How should each of the local factors--resources, students, and aims--be considered when deciding which tasks to select from a V-TECS catalogue? No one factor can be considered independently, Rather all three must be considered together. To see why this is so, let us briefly examine the decisions that must be made in order to use a V-TECS catalogue.

In order to select tasks from a V-TECS catalogue, three decisions must be made: (1) How many duty statements to select, (2) which tasks to select, and (3) the relative instructional importance of the tasks that are selected.

The decision as to the number of duty statements to consider related to the scope of the program. Program scope can be defined as the total number of duty statements from which tasks are selected. This is a question that directs itself to the instructional resources that are available. More duty statements are selected and greater numbers of tasks taught when there are ample resources, fewer when there are less resources. The decision as to how many duty statements to select, however, is also a question of instructional aim. The aim may only be to provide a program of a certain

scope--that is, to teach only a limited number of tasks for a given student population.

The question of which tasks to select is largely one of the aims of instruction, although student population and resources are also considered. What does the instructional designer want to accomplish? Certain job tasks can be selected to achieve one purpose, while other tasks are more appropriate in order to achieve another aim. Markedly different tasks would be selected, for example, if the aim is to provide general exploratory experiences for 10th graders rather than skill development for a community college level technical program. But it is also true that the instructional aim is partially determined by the available instructional resources. Put another way, it is not possible to provide instructional services without the required supporting resources.

The question of the relative instructional importance of tasks is also mainly one of aim. As suggested, some tasks relate more closely to a particular instructional aim than do other tasks. It is also reasonable to assume that some tasks are more important than others for performing a specific job function. If the aim of instruction is to train for this function, then the tasks associated with that function are more important for instructional purposes than other tasks. Program aim, however, is partially determined by the resources that are available and the characteristics of the student population served.

As can be seen, the decision-making process can be rather complex because of the many variables involved. Information

concerning program aim, the student population, and instructional resources needs to be balanced together to arrive at decisions concerning program scope, task selection, and task importance. Moreover, there is no simple way to develop a prior, standard set of instructional tasks without seriously limiting local options. To be most effective, program design must evolve out of local decisions. The decision-making process, however, can be simplified by completing a series of decision-making steps. The first step is to determine program scope.

Determining Program Scope

The scope of the program can be considered to relate to the total number of duty statements from which tasks are selected. As previously suggested, the tasks in a V-TECS catalogue are grouped under duty statements. In the automotive mechanics catalogue, for example, the following duty statements are included:

Performing Engine Overhaul Activities
Maintaining and Repairing Cooling Systems
Maintaining and Repairing Fuel Systems
Maintaining and Repairing Automatic Transmissions
Maintaining and Repairing Power Trains
Maintaining and Repairing Standard Power Steering Units
Maintaining and Repairing Front Ends
Maintaining and Repairing Braking Systems
Maintaining and Repairing Electrical Systems
Maintaining and Repairing Automobile Air Conditioners and Heaters

The instructional designer may select tasks from only one duty statement, such as "Performing Engine Overhaul Activities." This would obviously result in a program of less scope than if tasks were selected from three, four, or even all of the duty statements.

To determine the scope of instruction, it is necessary to decide how many duty statements to consider. There are three options:

1. To provide instruction in the tasks listed under only one duty statement
2. To provide instruction in the tasks listed under more than one duty statement, but less than all
3. To provide instruction in the tasks listed under all of the duty statements

To decide which option to follow, it is necessary to consider local conditions relating to instructional aim, the student population being served, and the available instructional resources.

Only one duty statement. Few programs will include tasks from only one duty statement. There are circumstances, nevertheless, when a program of this scope is desirable. This may occur when:

- The aim of the program is to provide retraining or upgrading in a single occupational category, such as engine overhaul. The program is designed as a single instructional unit, narrow in scope, involving, however, depth of coverage.
- The student population consists of young adults who have made a definite career choice, and who have the prospects of immediate employment or upgrading in the occupational specialty upon completion of instruction. Narrowly based instruction is justified under conditions of immediate

employment, clearly defined job tasks, and definite student choice.

- The instructional resources are very restricted, so the decision is made to provide training in one subcategory of a job that has ample employment opportunities.

More than one duty statement, but less than all. This is probably the most common way that the V-TECS catalogue is used. Most progams will provide instruction in tasks listed under more than one duty statement because of the greater breadth of instruction provided. On the other hand, some of the duty statements may not be considered because they may be inappropriate to the aim of instruction or the student population. They may also require unavailable resources. A program of this scope may be appropriate if:

- The instruction aim is to provide a balanced approach to instruction in the field of study. Variations in student background, ability level, interest, and goals can be best accommodated.
- The occupational goals of all students are not yet clearly defined, so a broadly based instructional program is desirable, resulting in a number of placement or training options. Some duty statements, however, may be beyond the ability or interest level of students.
- The tasks included can be taught with available resources. This includes equipment, personnel, and time. Some duty statements will be eliminated because of these constraints.

All duty statements will be included. There are some cases when all duty statements will be included in the instructional

program. This may be desirable when:

- There is a commitment to a broadly based, comprehensive coverage of the occupational field. Employment conditions, as well as the age and characteristics of the student population suggest such an approach. The option may be to achieve breadth-of-coverage, rather than depth-of-coverage.
- The student population is very heterogeneous, and occupational goals may not be clearly defined.
- There are ample instructional resources available to support the program.

Judgements regarding the number of duty statements to consider basically relate to the specificity of instruction. In general, the older the student population is and the more immediate job placement is, the more specific and narrowly defined instruction can be. For younger students, instruction should be broadly conceived, in order to provide wide exposure. If employment is less immediate, instruction should be less specific in order to promote future flexibility. If the student group is heterogeneous, instruction should be less specific. Of course, these considerations must be tempered by available resources. Limited resources mandate a limited instructional program.

Which Tasks to Select

Determining program scope is the first step in selecting tasks from a V-TECS catalogue. The second step is deciding which

tasks to select. All of the tasks listed under a given duty statement may not be selected for inclusion in the instructional program. The decision, for example, may be made to include only certain highly technical tasks, since the students may have already had prior instruction in some of the lower level tasks listed under a duty statement. Again, the decision may be made to select only lower level tasks from all of the duty statements, since the aim of the program may be to provide initial exploration experiences, to be later followed by other specialized technical courses. It can be expected, then, that the specific number of tasks selected will vary from program to program, depending upon local concerns.

Again, there are three options to consider when determining which tasks to select:

1. To provide instruction in all of the tasks listed under each selected duty statement
2. To provide instruction in all of the tasks listed under some of the selected duty statements, and only some of the tasks listed under other selected duty statements
3. To provide instruction in only some of the tasks listed under all of the selected duty statements

In general, a greater number of tasks will be selected for each duty statement when only a few duty statements make up the instructional program. This is because when few duty statements make up the program, greater specialization results, which in turn calls for greater depth of coverage. In other words, a

program narrow in scope usually has greater depth of coverage.

Conversely, when more duty statements make up the instructional program, there will be greater variability concerning the number of tasks selected. In such a case, the aim is usually breadth of coverage, and all duty statements simply do not have to have great depth of coverage. Specialization may not be desirable for some duty statements, or the tasks may be inappropriate for the student population being served. Then too, there may not be adequate resources to teach all of the tasks listed under all of the selected duty statements.

As in the case of determining program scope, when deciding how many tasks to select, it is necessary to consider program aim, the student population being served, and the instructional resources that are available. More specifically, the investigators should ask:

- Is this task appropriate to the aim of the program, or are there other tasks of greater priority?
- Is this task appropriate for the student population being served in terms of ability level, background, training goal, and interest?
- Can this particular task be taught with the available resources in terms of equipment, supplies, staff, and instructional time?

So far we have considered program scope, and the fact that programs will vary in scope. We have also considered the fact that programs will vary in the number of tasks selected for instruction. One can, in other words, develop different program

profiles to meet different local considerations. The following figures illustrate the concept of program profile.

Figure 2 presents an instructional program that is highly specialized in one duty. However, some tasks listed under two other duty statements are included because they relate to the area of specialty.

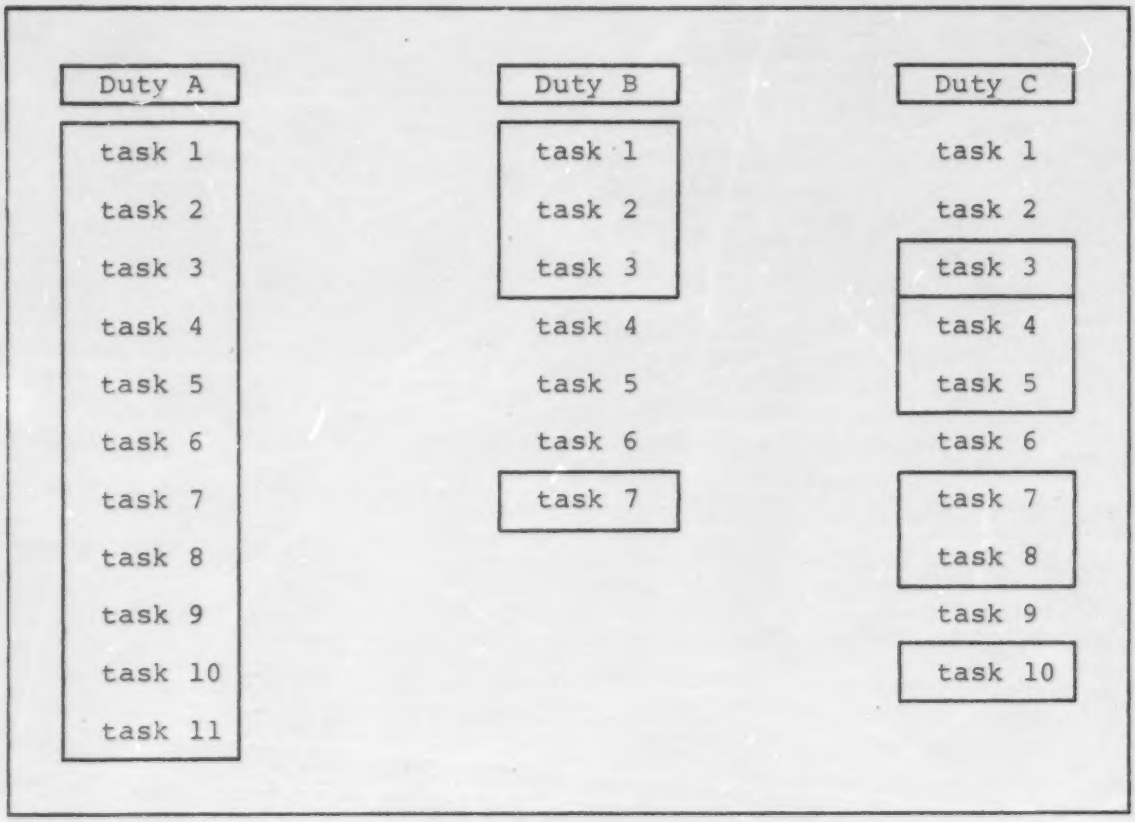

Fig. 2. Program highly specialized in one duty

In figure 3, a program broader in scope, and less specialized is shown. It obviously requires more resources to teach.

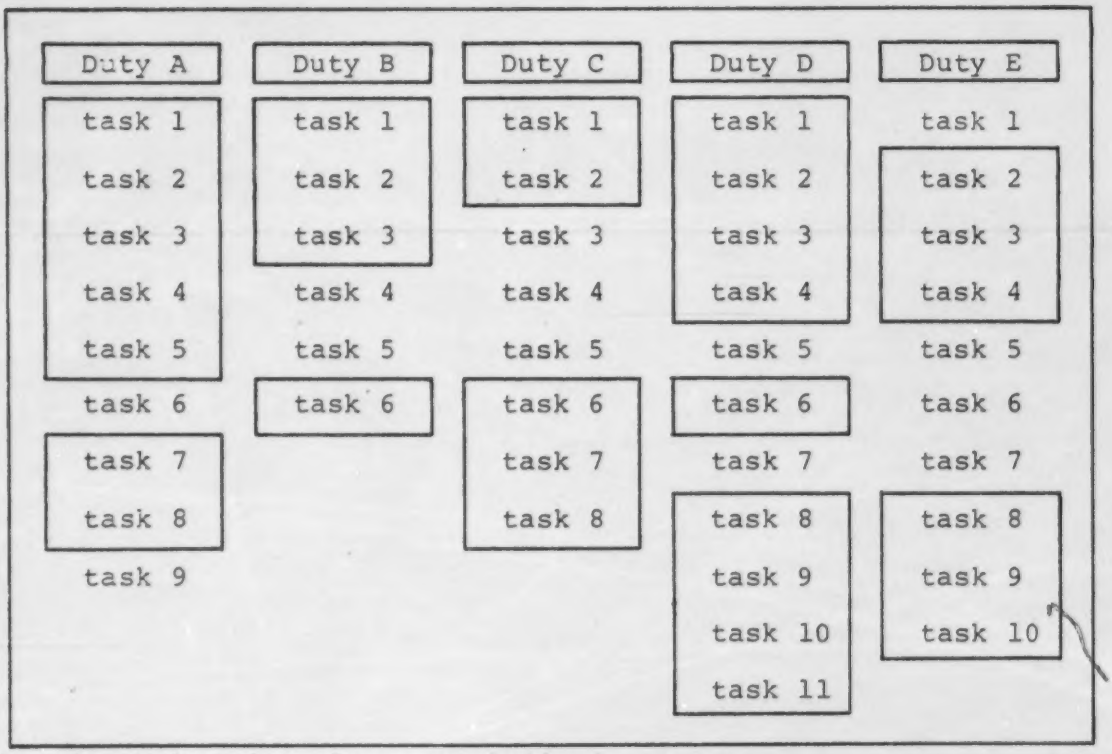

Fig. 3. A broader, less specialized program

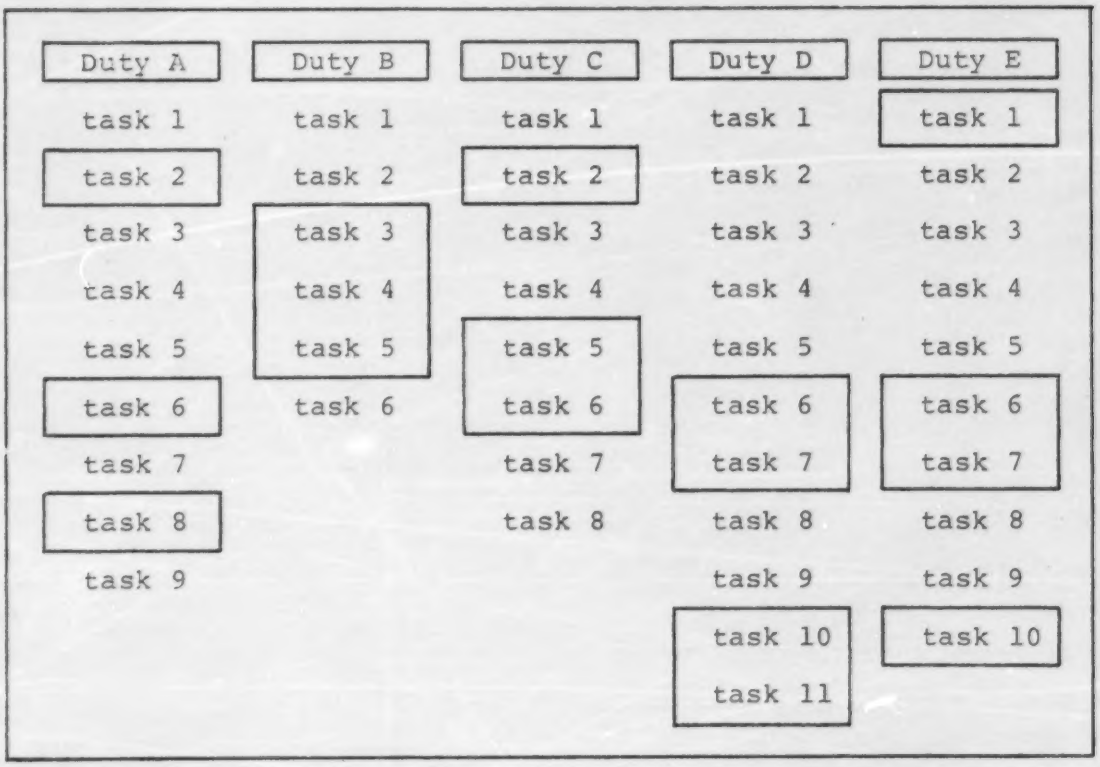

Fig. 4. Less specialized program for special needs students

In figure 4, the same duty statements are included as in figure 3. However, this program provides less specialization and a lower level of training, since it is for special needs students training for different job categories in occupational areas that require less experience and background.

It will be found, then, that even though the same V-TECS catalogue is used, the program profile developed will vary greatly from one instructional situation to another. This is because program aims vary, different students are served, and different resources are available.

In a following section, the use of the Q-Sort procedure to select tasks appropriate to local program conditions will be covered. Now, however, let us turn our attention briefly to the question of the relative instructional importance of the tasks that are selected for inclusion in the program.

Relative Importance of Tasks

Not all of the tasks selected are of equal importance for instructional purposes. Some of the tasks must be learned to a high degree of mastery. Personal safety may be involved, or the task may be extremely difficult to perform on the job, so extended formal instructional time must be provided for these tasks. The converse is also true. Some tasks need only minimal attention in the formal instructional setting. Thus, not only is it necessary to determine which tasks in a V-TECS catalogue will be included in the instructional program, but it is also necessary to differentiate between the relative importance of

these tasks. Important tasks should receive more instructional emphasis; less important tasks should receive less emphasis.

As will be discussed in a later section, the Q-Sort procedure provides a way to assign relative importance to tasks. One outcome of this procedure is a ranking of tasks, from the most important, to the least important. Once this ranking is achieved, it is possible to allocate instructional time on the basis of task importance. Thus, the error of treating all tasks with equal instructional emphasis is avoided.

It was previously suggested that in order to select tasks from a V-TECS catalogue three decisions must be made: (1) How many tasks to select, (2) which tasks to select, and (3) the relative instructional importance of the tasks that are selected. The preceding discussion has been an attempt to develop a conceptual framework in which these decisions can be addressed. When there is a better understanding of the nature of the judgements that need to be made, greater objectivity results. Greater objectivity also results when carefully designed procedures for task selection are followed. The following section will discuss the Q-Sort procedure. This is a procedure that considerably simplifies the process of selecting tasks from a V-TECS catalogue.

What is a Q-Sort?

The Q-Sort is a procedure for assigning priorities to related items; in this case, the job tasks listed in a V-TECS catalogue. The Q-Sort makes use of the idea of "normal distribution." When tasks are sorted into a normal distribution, the

result is a more discriminating sort, more so than if just a simple ranking was used. By use of the Q-Sort, it is also possible to distinguish between the relative importance of job tasks. That is, the task statements are sorted according to their instructional importance. The most important job tasks are arranged at the left side of the sort, tasks of less importance are arranged next in order of decreasing importance, and those tasks of least importance are placed at the right side of the sort (see figure 5).

Q-Sort Reporting Form

ID _____

Directions: Each card has an identification number in the upper right hand corner on the back of the card. After the sort is completed, list the number on each card in the appropriate group below.

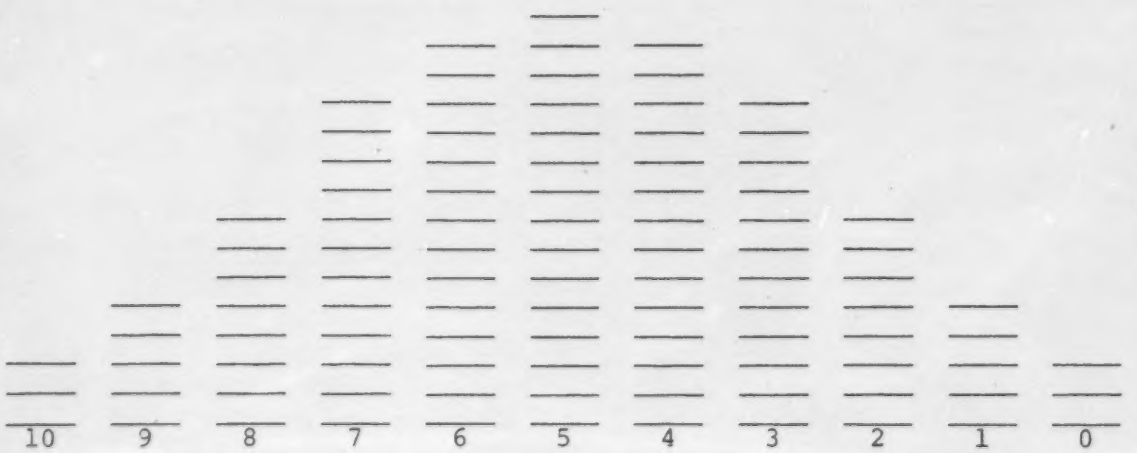

Fig. 5. Q-Sort Reproting Form

In figure 5, note that three tasks are placed in category 10. These are the three most important instructional tasks. Next, five tasks are placed in category 9, and so on.

There are a number of advantages in using the Q-Sort technique. Because the Q-Sort technique involves interaction between the investigator and the sorter, it is suitable for collecting information on a variety of questions previously identified as being necessary for determining the relative instructional importance of task statements. Furthermore, the degree of task importance can be clearly indicated. Thus, it is possible to readily determine the relative importance of a specific task in relation to other tasks. As previously suggested, this is an important consideration when dealing with the problem of adjusting instructional content to resource constraints. The information is easily tabulated and analyzed. It is also possible for the sorter to compare all of the items on the cards with each other. In this way, responses can be adjusted as the sorter works through the process. Finally, this procedure is appropriate for use by the individual classroom teacher, and it can be used when working with a small number of individuals and restricted budget.

There are also obvious disadvantages to the Q-Sort technique, the main one being that it is impractical for examining a large number of tasks. If tasks can be organized into duty statements, and if the individuals sorting are asked to respond to small segments of the total task listing, this objection can be largely overcome. This point will be examined in the next

section as the use of the Q-Sort technique is examined in greater detail.

Use of the Q-Sort

The basic application of the Q-Sort procedure is straightforward:

1. List each duty statement in the selected V-TECS catalogue on a 3 x 5 card. It is necessary to sort through the cards and eliminate those duty statements that are not appropriate for the instructional program.
2. For the remaining duty statements, list all of the tasks on 3 x 5 index cards. This will make up the sorting deck.
3. The task cards should next be rough-sorted into categories. These categories include tasks which are (a) closely related, (b) somewhat related, and (c) totally unrelated to the program. This provides a way of quickly eliminating inappropriate tasks and reducing the number of tasks to final sort. Figure 6 provides an example of a Preliminary Sort Reporting Form that can be used for rough-sorting.
4. A forced distribution can be made of the clearly related and somewhat related tasks and the results can be recorded on the Q-Sort Reporting Form (figure 5). This procedure is then repeated for each question considered necessary for assessing the instructional importance of the tasks.

6. The results of the Q-Sorts can be tallied and a master task list compiled.

Preliminary Sort Reporting Form

ID _____

Directions: Each card has an identification number in the upper right hand corner on the back of the card. Record the number of each card under its appropriate heading. Beyond getting each card into one of the three groups, the order of writing them down is unimportant.

Related	Somewhat Related	Unrelated
____ ____ ____ ____	____ ____ ____ ____	____ ____ ____ ____
____ ____ ____ ____	____ ____ ____ ____	____ ____ ____ ____
____ ____ ____ ____	____ ____ ____ ____	____ ____ ____ ____
____ ____ ____ ____	____ ____ ____ ____	____ ____ ____ ____
____ ____ ____ ____	____ ____ ____ ____	____ ____ ____ ____
____ ____ ____ ____	____ ____ ____ ____	____ ____ ____ ____
____ ____ ____ ____	____ ____ ____ ____	____ ____ ____ ____
____ ____ ____ ____	____ ____ ____ ____	____ ____ ____ ____
____ ____ ____ ____	____ ____ ____ ____	____ ____ ____ ____
____ ____ ____ ____	____ ____ ____ ____	____ ____ ____ ____
____ ____ ____ ____	____ ____ ____ ____	____ ____ ____ ____
____ ____ ____ ____	____ ____ ____ ____	____ ____ ____ ____
____ ____ ____ ____	____ ____ ____ ____	____ ____ ____ ____

Fig. 6. Preliminary Sort Reporting Form

While the application of the Q-Sort procedure is straightforward, there are, however, a number of procedures that need to be explained in more detail. Probably the most important to consider is the number of tasks to be sorted.

The sorting procedure varies according to the number of tasks to be sorted. For one thing, there is a practical limit to the total number of tasks that can be considered. The maximum is approximately 150 tasks. To attempt to sort more than 150

tasks makes the procedure cumbersome and tedious. And, just as there is an upper limit to the number of tasks that can be easily sorted, it becomes trivial to sort less than approximately 25 tasks.

What should be done in cases with more than 150 tasks to be sorted? In the first place, the number of the tasks can be reduced through the preliminary sort (see figure 6). This is its purpose. If a larger number of tasks still remain after the preliminary sort, simply divide the total number of tasks and make two or more separate sorts. This can easily be done by using duty statements as subgroupings. In the case of a small number of tasks within a duty statement, group together more than one duty statement in order to exceed the minimum of 25 tasks.

After the preliminary sort, it is necessary to count the total number of tasks that will be involved in the final sort. This is necessary because the total number of piles into which the tasks are to be sorted and the number of tasks that are to be put into each pile need to be determined. For example, if less than 75 tasks are to be sorted, then there will be nine piles. If the number of tasks is greater than 75, then there will be eleven piles (see table 1). The number of tasks to include in each pile also needs to be determined. In other words, the sorting pattern corresponds directly to the number of tasks to be sorted. For example, if 85 tasks are to be sorted, then they will be put into the following sorting pattern:

2 tasks into pile #10	13 tasks into pile #4
3 tasks into pile #9	9 tasks into pile #3

5 tasks into pile #8

9 tasks into pile #7

13 tasks into pile #6

23 tasks into pile #5

5 tasks into pile #2

3 tasks into pile #1

2 tasks into pile #0

Table 1 provides an easy way of establishing the number of piles required for a sort. By using table 1, a "normal distribution" can be maintained throughout the sort.

No. of Tasks \ Pile #	Most Important 10	9	8	7	6	5	4	3	2	1	Least Important 0
25			1	2	3	4	5	4	3	2	1
30			1	2	4	5	6	5	4	2	1
35			1	3	4	6	7	6	4	3	1
40			2	3	4	7	8	7	4	3	2
45			2	3	5	8	9	8	5	3	2
50			2	4	6	8	10	8	6	4	2
55			2	5	6	9	11	9	6	5	2
60			2	5	7	10	12	10	7	5	2
65			3	5	7	11	13	11	7	5	3
70			3	6	8	11	14	11	8	6	3
75			3	6	8	13	15	13	8	6	3
80	1	3	5	8	13	20	13	8	5	3	1
85	2	3	5	9	13	21	13	9	5	3	2
90	2	4	5	9	14	22	14	9	5	4	2
95	2	4	6	9	15	23	15	9	6	4	2
100	2	4	6	10	16	24	16	10	6	4	2
105	2	4	6	11	17	25	17	11	6	4	2
110	2	4	7	11	18	26	18	11	7	4	2
115	2	5	7	12	18	27	18	12	7	5	2
120	3	5	7	12	19	28	19	12	7	5	3
125	3	5	8	12	20	29	20	12	8	5	3
130	3	5	8	13	21	30	21	13	8	5	3
135	3	5	8	14	22	31	22	14	8	5	3
140	3	6	8	14	22	34	22	14	8	6	3
145	3	6	9	14	23	35	23	14	9	6	3
150	3	6	9	15	24	36	24	15	9	6	3

Table 1. Sorting Pattern

The sorting can be facilitated through a set of guide cards. These are cards that list the pile number and the number of tasks to be included in the pile. On the far left card write "most related," and on the far right card write "least

related (see figure 5). The sorter can arrange and tape the guide cards across a desk or table top to establish the sorting piles. The guide cards can be used to (a) identify the pile number, (b) identify the number of tasks to be put into each pile, and (c) indicate the direction of value from "most" to "least" related.

If the Q-Sort is to be performed by more than one person at a time, make additional sets of task cards. For each set, it is necessary to randomize the cards. This can be accomplished by shuffling the deck to put the cards into random order. Record this order so that the cards can be presented to each successive sorter in the same numerical order. This helps to insure uniformity throughout the sorts.

The primary Sort Reporting Form and Q-Sort Reporting Form can be used to record the sorts of the individuals sorting. In this way, a permanent record can be maintained for future use.

The recording procedure is uncomplicated. If five task cards are put on pile #9, for example, then the numbers listed on the back of these cards should be recorded by the Q-Sort Reporting Form. These tasks would each receive a score of 9. Always score the sort in the same value direction so that pile =10, for example, corresponds to the "most important," and pile =0 corresponds to the "least important."

As the scores for the various sorts are accumulated, they can be averaged and the entire set of task cards can then be ranked. The highest total scores will indicate the tasks valued

as most important in the judgement of all sorters. Succeeding tasks will be ranked in descending order of importance.

Finally, every effort should be made to standardize the administration of the Q-Sort so that sorting done during one session or by one person can be compared to the sorts done at another time. In addition, the person administering the Q-Sort should not try to influence the sorting.

Interpretation of the Sort

The Q-Sort provides a means of selecting tasks as well as differentiating between the relative instructional importance of tasks. Through the use of the preliminary sort, inappropriate tasks are eliminated. Task selection can be carried an additional step further by working from the "most related" tasks to those "least related." Depending upon resource constraints, those tasks in category "0" would be the most probable tasks eliminated from the instructional program, those in category "1" next, and so on, until a cut-off point is reached that yields an appropriate number of instructional tasks.

Moreover, through the use of the Q-Sort, tasks are ranked in terms of importance, so it is relatively simple to differentiate between the relative importance of the tasks. One way to do this is to divide the sorted tasks into levels approximating the distribution expected from a normal distribution (see figure 7). Approximately 15% of the tasks listed at the far left of the sort are assigned to level 4. Next, assign approximately 34% to level 3, and so on. The level identifies the relative

instructional importance of the tasks (see figure 7). The instructional designer, however, should not hesitate to be flexible, since this procedure provides only a rough approximation.

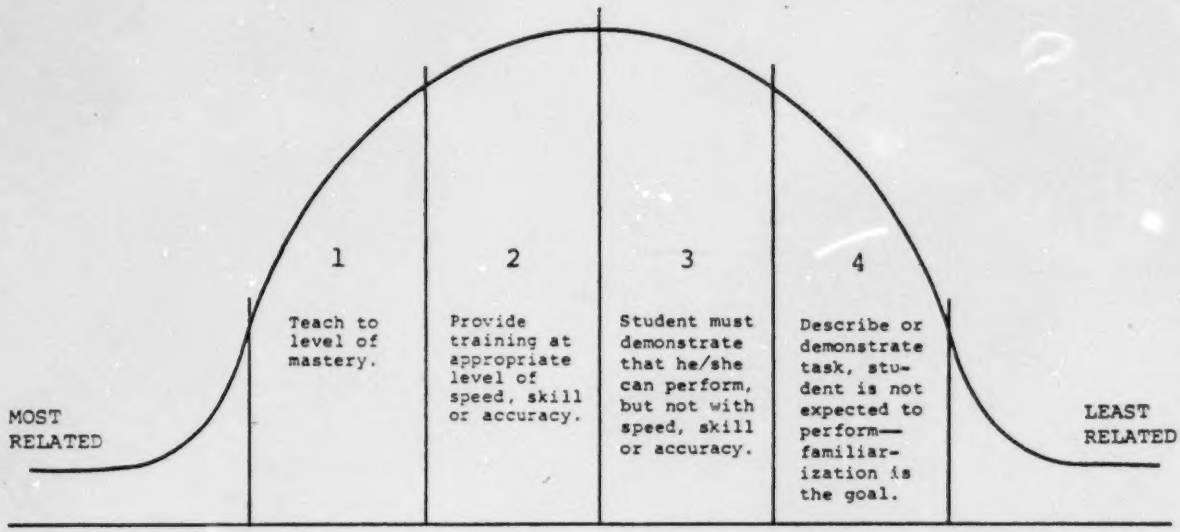
MOST RELATED
1
Teach to level of mastery.
2
Provide training at appropriate level of speed, skill or accuracy.
3
Student must demonstrate that he/she can perform, but not with speed, skill or accuracy.
4
Describe or demonstrate task, student is not expected to perform— familiarization is the goal.
LEAST RELATED

Fig. 7. Task levels and instructional emphasis

The levels assigned to the tasks provide a useful index in allocating instructional time and determining the required proficiency of training. A task at the level of 4, for example, must obviously be mastered and the necessary instructional time allocated.

The Instructional Design Committee

The Q-Sort procedure works best when several individuals are involved in the sorting. Personal bias is eliminated, and a more balanced, comprehensive sort usually follows.

It is recommended that from three to eight individuals comprise an instructional design committee. Of these, the

committee chairperson should be responsible for organizational and administrative duties. The chairperson may not actually participate in sorting, but should be in charge of the overall monitoring of the procedure. Laboratory teachers should be committee members, but they should not make up the majority of the composition, and they should be subject-matter experts in the field under study. The remainder of the committee should be made up of incumbent workers and employers in the field. These individuals represent employing agencies.

Care has to be exercised in selecting committee members, since the sort will be only as good as the understanding of the individuals selected. If the committee is constituted mainly of individuals in a supervisory capacity, the detailed understanding of job activities may be lost, since these individuals may have been separated for some time from daily contact with the job at the performance level. On the other hand, some incumbents may not have the scope of vision to see their job within the total context of the broad occupational field and the result can be an unduly restricted sort. Again, individuals in a specialized aspect of an occupational field may have the tendency to stress only those activities which are related to their specialty. If the aim of the program is to provide training in this specialty, then these individuals are desirable committee members. However, if the aim of the program is for a broader treatment of the occupational field, then committee members with a broader perspective are desirable. In sum, the advisory committee should be comprised of responsible, capable individuals selected because their

collective input will result in a balanced and comprehensive treatment of the occupational field.

It is also obvious that if the instructional design committee is fully advised of its role and of the expected outcomes, there will be a greater assurance of a valid sort. Perhaps the best way to examine the role of committee members is to review the total task selection procedure.

Selecting Tasks

It has been previously suggested that the first decision that needs to be made is to determine program scope. Program scope is defined as the total number of duty statements from which tasks are selected. It is possible to provide instruction in the tasks listed under:

1. Only one duty statement
2. More than one duty statement, but less than all
3. All of the duty statements

In order to decide which option to select, committee members should examine all of the duty statements included in the V-TECS catalogue under consideration in order to become familiar with the tasks associated with each duty statement. It is then necessary for the committee members to discuss among themselves the basis of deciding which duty statements to include in the instructional program and which to exclude. A thorough understanding of local program aims is essential. Should instruction be very specific and restricted to only a few duty statements? Should it cut across all duty statements? In order to

address these and similar questions, it is necessary for the committee to fully consider the student population being served and the resources that are available. Any judgements made in regard to program scope is a judgement requiring consideration of all local factors influencing instructional design. Figure 8 lists some basic decision-making guidelines for determining program scope.

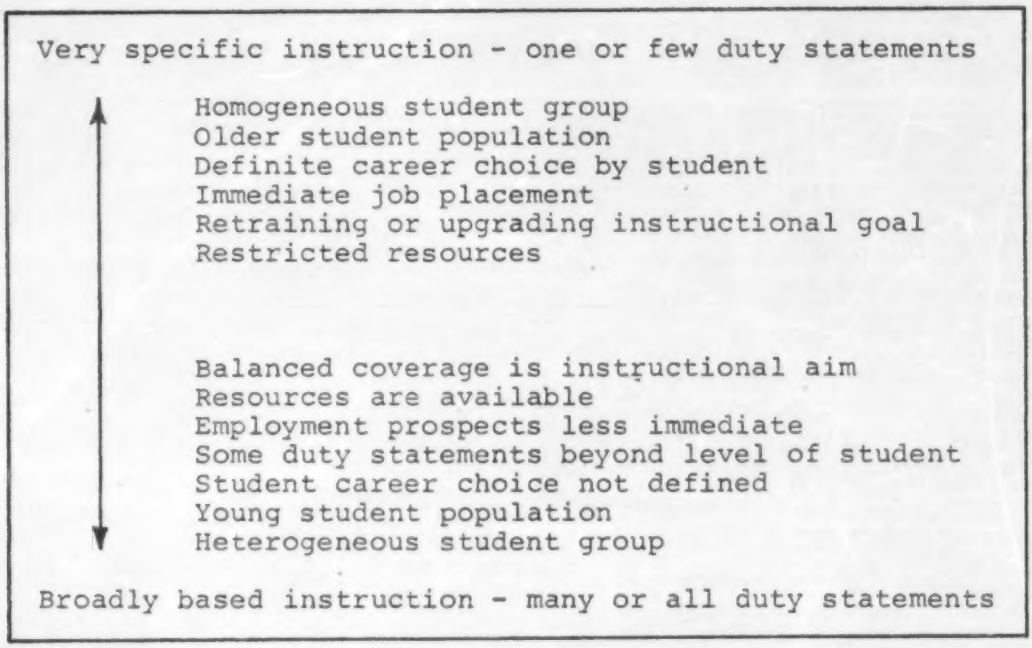
Very specific instruction - one or few duty statements
Homogeneous student group
Older student population
Definite career choice by student
Immediate job placement
Retraining or upgrading instructional goal
Restricted resources
Balanced coverage is instructional aim
Resources are available
Employment prospects less immediate
Some duty statements beyond level of student
Student career choice not defined
Young student population
Heterogeneous student group
Broadly based instruction - many or all duty statements

Fig. 8. Decision-making guidelines

The major responsibility of the instructional design committee chairperson is to see that all committee members have an understanding of the basis of decision-making. As previously suggested, moreover, decision-making is largely a judgemental process, one involving tentative decisions that can be expected to be altered as new judgements are considered. The chairperson

should encourage the committee members to work back and forth between tentative decisions until a final, fully accepted decision is reached. The duty statements that are selected define the scope of the program. It is from these duties that the instructional tasks will be selected.

By the time the committee is ready to proceed with selecting tasks, the members should be fully aware of the kind of instructional program that would best serve local interests. At this point, task cards are constructed for each selected duty statement, making up the sorting deck. Each committee member should proceed individually to sort the task cards. First, preliminary sorts in order to eliminate totally unrelated tasks. The sorter should make three sorts, one for each of the following questions:

1. Should this task be eliminated because it is totally unrelated to the program aims?
2. Should this task be eliminated because it is totally unrelated to the needs of the student population being served?
3. Should this task be eliminated because it cannot be taught with available resources?

The results of the sorts should be tallied and unrelated task cards removed from the sorting deck.

Next, the forced distribution should be made out of somewhat related and clearly related task cards. Again, the sorter should make three sorts, one for each of the following questions:

1. Is this task most related to program aims?
2. Is this task most related to the needs of the student?

population being served?

3. Is this task most related, given available instructional resources?

Once the sorts are tallied from all committee members, the total committee should be brought together in order to examine the compiled master task list. While discussion is useful, at this point charges probably should not be made unless this is substantial agreement among committee members.

Selected Examples of Sorts

Following are two examples of the sorting procedure applied to the field of automotive servicing. This one occupational field was sorted under two different sets of conditions in order to demonstrate the development of different instructional problems.

In the first sort, the aim is to provide a general automotive course that will lead to entry level employment as a service station attendant and mechanic's helper. It is assumed that some skills can be learned through OJT. The basic resources to provide the course are available. The student population is characterized by average or low ability, with poor academic background but high interest.

In the second sort the objective is to provide a third year specialized course leading to placement as an apprentice in a general repair garage or dealership. The students have had prior exposure to some of the tasks during the preceding two courses. On the other hand, some tasks can be learned to the

level of mastery through OJT. This is a select student group, comprised of students who have successfully completed prior automotive courses and who have demonstrated interest and ability. Adequate resources are available.

For both sorts, the tasks are listed according to instructional levels.

Task Listing for General Automotive:

Duty Statements Selected:

Maintaining and repairing cooling systems; maintaining and repairing electrical systems; maintaining and repairing fuel systems; maintaining and repairing front ends; maintaining and repairing braking systems; maintaining and repairing standard and power steering units; performing engine overhaul activities.

Level 4 tasks.

Replace points and condenser; lubricate ball joints; balance wheels and tires; replace starter; replace radiator hoses; inspect and test windshield wiper motor, blades, and arms; test thermostat; replace coil of the primary circuit; chemically clean and flush cooling system; clean gap, and test spark plubs; inspect, adjust, or replace fan belts; repair or replace lighting system components; lubricate the front and rear suspension; perform operational inspections of positive crankcase ventilation system; service or replace batteries, cables, and battery box; replace fuel filter; inspect, service, or replace carburetor air cleaner; set ignition timing;

Level 3 tasks.

Perform operational inspections of engine lubrication systems; adjust backup light switches; repair or replace fuse block assembly; check coolant freezing point; perform visual inspections of the suspension systems; perform operational inspections of exhaust emission control system; replace filter in power steering; check coolant temperature; lubricate steering gear and linkage; adjust parking brake linkage; remove and replace oil pans; inspect and replace brake pads (disc brakes); check manual steering gear fluid level; adjust carburetor; replace generators and alternators; steam clean engines; adjust valves; install carburetor; replace ball joints; replace engine mounts; replace water pump; perform cylinder compression test; clean engine parts and check for

condition; reline brake shoes; remove and replace fuel pump; replace belts and adjust tension; replace wheel cylinder; check and align front end; perform operational brake inspections; adjust brakes; replace brake shoes; replace variable speed fan; inspect and refinish brake drums; replace thermostat; replace muffler(s); replace tailpipe assemblies; inspect exhaust system; replace flasher units; remove engines from vehicle; adjust headlights; replace ignition switch and resistor; locate and repair shorts and open circuits in wiring; perform operational inspection of lighting systems; check overflow tank; clean moisture or foreign particles from fuel system; adjust and repack front wheel bearings; adjust front wheel bearings; inspect wheel bearings; inspect steering gear; replace heater hoses; replace shock absorbers and mounting; repair or replace charging system regulators; bleed hydraulic brakes; replace solenoids; repair or replace fuel lines and hoses; free-up parking brake cables; repair or replace switches; pressure test cooling system; clean fuel filter;

Level 2 tasks.

Replace power steering components; replace power steering pump; replace hydraulic power cylinders; inspect and replace self-adjusters; measure fuel flow and pressure; inspect and replace steering damper; test and repair transistor ignition systems; inspect points and condenser of the primary circuit; analyze or adjust engine performance using engine analyzer; replace master cylinder; analyze malfunctions in the cranking system; inspect steering linkage; replace parking brake linkage; repair generators or laternators; inspect and turn rotor (disc brakes); replace manual steering gear components; replace gas tank sending unit; remove and replace oil pump; replace hydraulic brake power units; inspect ignition switch, resistor, wiring, and coil of the primary circuit; perform cylinder leakage test; replace and adjust distributors; measure fuel flow and pressure; repair rear suspension system; inspect, clean, and adjust choke unit (automatic); inspect, clean, and adjust choke unit (manual); repair or service carburetors; repair self-adjusters; replace hydraulic control valves; perform chemical cylinder leakage test on cooling systems; analyze for moisture or foreign particles level in fuel system; repair windshield wiper mechanisms and controls; test and rewire dash units; repair tilt and telescoping steering wheel; solder minor leaks in radiators; replace chassis and underhood wiring; rebuild hydraulic brake power units; recondition backing plates; adjust or rebuild power steering units; check power steering fluid level; repair starters; disassemble engine; evaluate alternator/generator and regular output; adjust worm and sector in steering gear; replace core plugs (freeze plugs); replace rear suspension systems; grind valves; replace connecting rods and bearings; inspect head for warp; adjust torsion bars; replace valves; replace valve guides; replace valve seals; resurface valve seats; service rocker arm assembly; remove and

replace radiators; inspect and repair front suspension systems; repair wheel cylinder; replace front wheel bearing grease seal; replace manual steering linkage components; clean carburetor; replace exhaust manifold(s); repair master cylinder; replace torsion bars.

Level 1 tasks.

Diagnose valve train and head malfunctions; replace crankshaft and main bearings; inspect and correct bearing fit; inspect crankshaft and connecting rod assembly; repair disc brake calipers; replace flywheel and flywheel ring gear; replace pistons; replace piston rings; replace gaskets and seals; replace camshaft; replace camshaft bearings; replace timing gears and chains; replace gaskets and seals; replace valve lifters; service or repair manifold heat controls; perform cylinder balance test; arc grind brake shoes; inspect secondary circuit lead wires, distributor cap, and rotor measure resistance in secondary wires; test and repair cruise control units; replace collapsible mast jackets (steering columns); fit piston pins; rebush king pins or link pins; repair power steering pumps; rebuild power steering units; strobe distributor and modify or correct advance curves; replace steering spindles.

Task Listing for Third Year:

Duty Statements Selected:

Performing engine overhaul activities; maintaining and repairing power trains; maintaining and repairing automatic transmissions; maintaining and repairing standard and power steering units; maintaining and repairing braking systems; maintaining and repairing front ends; maintaining and repairing fuel systems; maintaining and repairing electrical systems; maintaining and repairing cooling systems; maintaining and repairing automobile air conditioners and heaters.

Level 4 tasks.

Replace universal joints; inspect and recharge system with refrigerant; remove and replace heater core; inspect drive shaft, u-joints, and center bearing; adjust clutch.

Level 3 tasks.

Adjust external shift linkage on manual transmissions; replace manual transmissions; replace speedometer cable and housing; pressure test system; service filter; replace neutral safety switch; leak test system; repair electrical circuits; service heater control components.

Level 2 tasks.

Adjust neutral safety switch; replace heater control units; replace evaporator in air conditioning unit; repair vacuum circuits; service air conditioner control cables; replace manual transmission rear seal, gasket, and bushing; diagnose air conditioning malfunctions; inspect and replace front pump, seal, and bushings; replace defroster hose; adjust column-type linkage; diagnose heating system malfunctions; replace rear axle shaft, bearing, and seal; replace transmission mounts; replace external seals, gaskets, and lines on automatic transmissions; replace air conditioning compressor; remove and install automatic transmissions; inspect, remove, and replace converter; install automatic transmission cooler (external type); lubricate universal joints; replace pilot bearing; repair or replace differential; adjust linkage form engine to automatic transmission; replace clutch release bearings (throw-out bearings); adjust floor linkage; clean and visually inspect transmission; replace mechanical-type clutch; diagnose differential malfunctions; replace expansion valve in air conditioning units; replace condenser in air conditioning unit; lubricate speedometer cable and housing; test manual transmission operation; replace speedometer drive gear.

Level 1 tasks.

Overhaul distributors; replace air conditioner fan motor; replace evaporator control valve or diaphragm in air conditioning unit; rebuild manual transmissions; evacuate air conditioning system; replace or adjust front drive axle assemblies; repair and adjust front drive axle assemblies; replace pinion seal; replace drier in air conditioning unit; replace and adjust modulators; repair hydraulic-type clutch; perform operational tests on automatic transmission.

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